We would like to thank the reviewer for the careful consideration of the manuscript. Please find our responses to each raised issue below in red. Underlined text highlights proposed changes in the manuscript.

This manuscript discribed a long time series CLARA albedo climate data record from 1979 to present. This dataset is esential to environmental supervision and climate change studies. This study presents the overview of the retrieval algorithm and the validation of the new released CLARA albedo products. The topic is interesting to the the journal of ESSD. However, several issues existed and made the manuscript hard to understand. My major concerns are following:

- What's the main improvement of the new released albedo products? The high quality, the higher spatial resolution or the more frequency?

The temporal coverage is now extended backwards and forwards, covering 1979-2020, with the continuously produced interim data record on top. Some quality improvements were evident following updates in AVHRR radiance intercalibration and a new, improved cloud screening method based on probabistic calculations. Also, previously unused AVHRR instruments were included in the timeseries, increasing sampling frequency for some years of the early record. And finally, CLARA-A3 now includes black-, white-, and blue-sky albedo estimates for all surfaces for the first time in CLARA editions. We propose to revise the first paragraph of conclusions to briefly list these improvements.

- Up to now, I could not download your datasets (using the link as you provided DOI). How can you guarantee data access on the NTP data center servers?

We verified that the DOI-provided link to the CM SAF data portal did work as required. A (free) registration on the portal before data ordering is required, as CM SAF project is obligated to track data user statistics. In the future, the CLARA records may also become available through e.g. the Copernicus data provision services.

- I suggest separating the contents of "data record description" from the current of "Data record description and algorithm overview".

Very well, we will revise the manuscript to separate the sections so that data record description is its own section, followed by the algorithm overview.

- There are too much describtion about the albedo retrieval algorithm. I suggest the author make it more logical.

Given that the white- and blue-sky albedo estimates are now available for the first time, we feel that their algorithms must be presented in sufficient detail. However, for the black-sky albedo, we think that the ocean albedo description on lines 154-168 can be considerably condensed without loss of information to the reader. The other descriptions of e.g. treatment of snow and ice are in our view required, as cryospheric applications of the data record are a primary user interest.

- Does the retrieval algorithm have some difference with the proposed aogorithm?

We are unsure of what is meant here. The algorithm as described in the manuscript is the one applied consistently through all of CLARA-A3 albedo products.

- Does the NTB method can be directly used to transfer the narrowband reflectance to broadband albedo? As we know, the NTB method were built following the assumption of the land surface is Lambertian.

Over land surfaces, the BRDF correction first normalizes observed reflectances to nadir Sun/View geometry, and then the spectral albedo is derived from those reflectances following Roujean et al. (1992). These spectral albedo estimates are then used as input to the narrow-to-broadband conversion of Liang (2000).

While the NTBC algorithm was indeed based on Lambertian surface assumption, Liang argues in the reference paper that "this assumption was only for calculating the spectral distribution of downward flux. It is known that the spectral downward sky radiance and the integrated flux are not very sensitive to the anisotropy of surface reflectance (e.g., Liang & Lewis, 1996). Therefore, this assumption should not impact the derived formulae in this study." We thus assume that the resulting uncertainty is contained within the overall uncertainty in the second-order polynomial equation used for AVHRR – inspection of Fig 7 in Liang's paper suggests that uncertainties of 5-10% (relative) are expected for the NTB conversion.

- Which method was used to reduce the topographic effects on the imageries? Does the AVHRR imageries have the serious topographic effects at so coarse-scale of 0.25° to 25km?

The topography correction is calculated at the native GAC resolution of ~5 kilometers during the level 2 processing. At this level, we expect that steep mountain ranges such as Alps and Himalayas will produce noticeable effects in the AVHRR imagery.

- Which BRDF correction method was used in this manuscript?

This is stated on lines 120-121, "The BRDF correction and conversion to narrowband surface albedos for AVHRR CH1 and CH2 continue to follow the kernel-based approach of Wu et al. (1995) and Roujean et al. (1992)."

- Does any gap exist in the current new released CLARA albedo products follows your strict selection of observations (such as the Sun Zenith Angle >70 deg. or Viewing Zenith Angle >60 deg)?

Certainly. Polar regions are not covered from late autumn until mid-spring due to the SZA limitation. Also, during the earliest years when the AVHRR constellation was in fact only a single satellite at a time, the pentad means may have data gaps also at lower latitudes due to the VZA limitation. To make this clear to the reader, we propose adding a brief summary of data gaps to section 5 after line 515. Furthermore, we will note emerging EO-based techniques that could fill gaps due to clouds and lack of illumination in future CLARA editions, see Jääskeläinen et al., (2022).

Jääskeläinen, E., Manninen, T., Hakkarainen, J. and Tamminen, J.: Filling gaps of black-sky surface albedo of the Arctic sea ice using gradient boosting and brightness temperature data, International

Journal of Applied Earth Observation and Geoinformation, 107,102701 (2022). doi:/10.1016/j.jag.2022.102701.

- How to screen out the snow-covered pixels for the retrieval of albedo over the global scale.

This is noted on lines 92-94, the snow covered area identification is handled during cloud parameter processing and is described in the given general reference paper of CLARA-A3.

- I can't understand the sentence "As AVHRR geolocation is calculated on a geodesic reference ellipsoid, a combination of sufficiently large elevation and viewing angle requires across-track shifting of pixels to obtain true geolocation" in Line 98-99 in page 5. Could you please explain it and make it more eaily to understand for the readers?

Thank you. This issue was also noted by reviewer #1, our response there contains the full explanation and a clarifying figure from the algorithm description document. Briefly, this refers to the fact that AVHRR geolocation is calculated over a smooth ellipsoid approximating the Earth's surface, which is not necessarily an accurate description over high-elevation areas. We correct for this when the assumption error is large, moving pixels within the AVHRR image. A similar approach for this type of correction is described by Dech et al. (2020) for their AVHRR processing. We will revise the text to make this clearer, also referring to the paper below.

Dech S, Holzwarth S, Asam S, Andresen T, Bachmann M, Boettcher M, Dietz A, Eisfelder C, Frey C, Gesell G, et al. Potential and Challenges of Harmonizing 40 Years of AVHRR Data: The TIMELINE Experience. *Remote Sensing*. 2021; 13(18):3618. https://doi.org/10.3390/rs13183618

- Does the SRTM have the DEM data between the surface that lies between the 56 degrees south to 60 degrees south latitude? As we all know, the SRTM's radars can cover most of Earth's land surface that lies between 60 degrees north and 56 degrees south latitude.

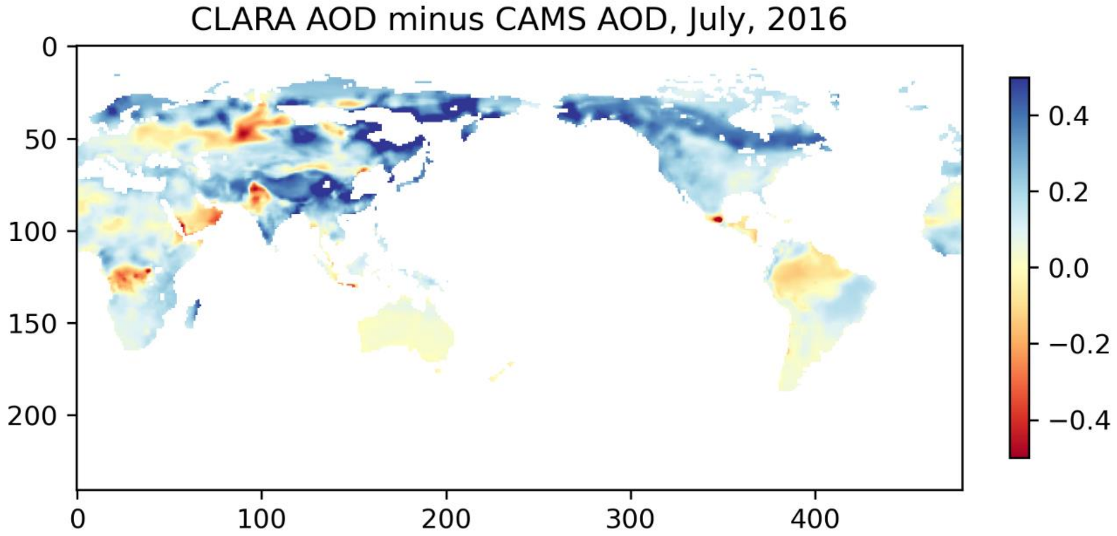
Thank you, this was indeed a mistake in the text. The SRTM coverage is 60 N – 56 S, with GTOPO30 being used elsewhere. We will revise the text accordingly.

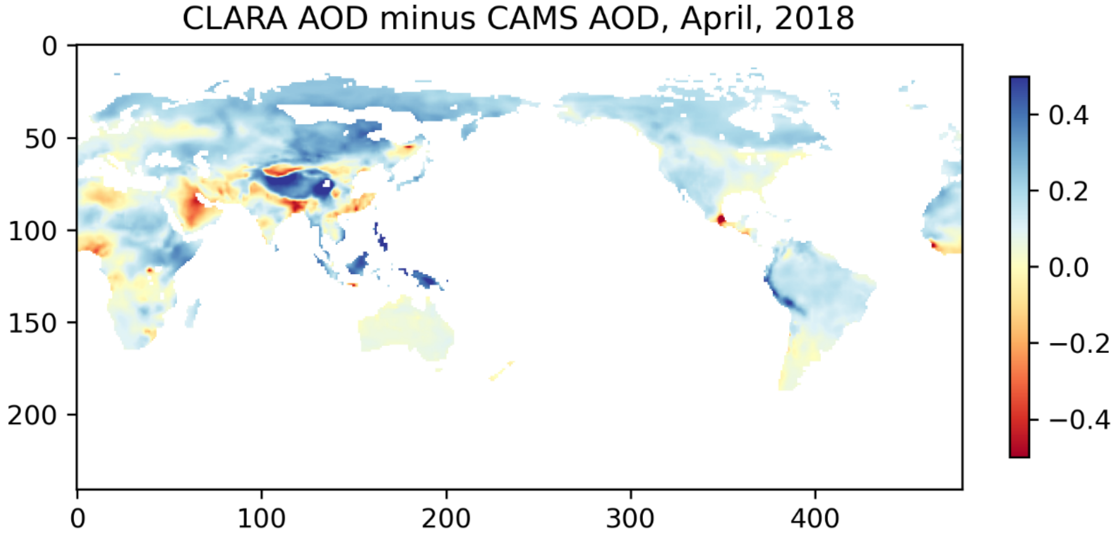
- What is the meaning of the word of "TOMS" in line L111, page 5? I can't find any describtion about this word.

TOMS refers to the Total Ozone Mapping Spectrometer, a NASA satellite instrument series which provided measurements of ozone and aerosols between 1978 and 2006. We will revise the text to add the full name of the instrument.

- I find that you used the AOD data from 2015 to 2014 to replace the AOD data from 2005 to 2014. How many uncecessary uncertainties were introduced?

Yes, years 2015-2020+ are covered by a climatology because of emerging issues in our aerosol data source instrument OMI. While this certainly does introduce additional uncertainty, as noted on lines 117-119, it is difficult to quantify the exact additional uncertainty. To obtain a general estimate for the reviewer, we obtained the CAMS monthly mean AOD550 data and calculated the differences to our AOD climatology for some example cases. Figures below illustrate the differences for April 2018 and July 2016. The data is resampled to the CAMS grid and resolution.

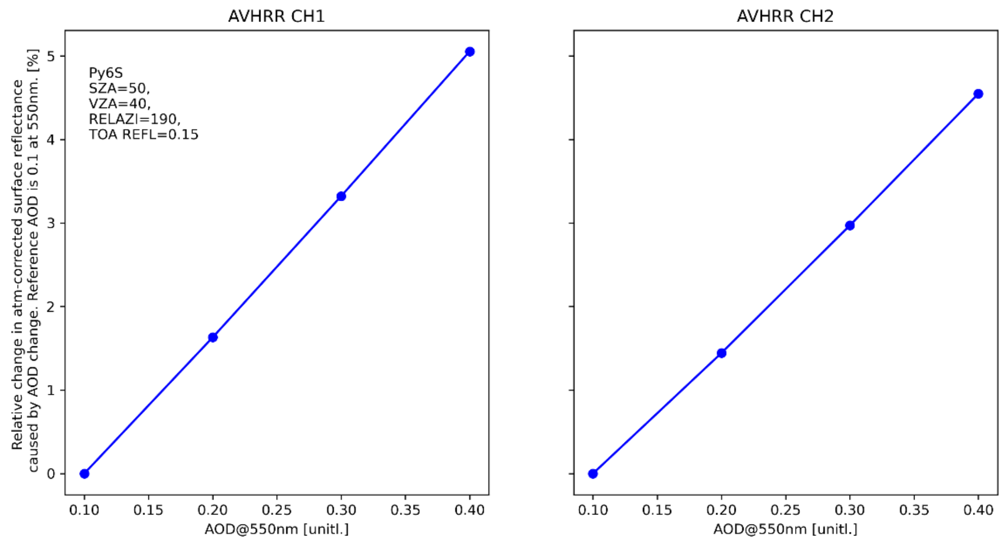




Larger differences occur over the boreal zone in summer, most likely with major contributions due to aerosols from forest and brush fires. Other large differences may occur over some tropical rain forest regions in Asia, as well as the Tibetan Plateau where CAMS AOD exhibits very small values, perhaps too small to be realistic.

To place these differences in context, we further did ATM simulations with the Py6S code (Wilson, 2013), as illustrated below. For an example case of (boreal) forests with a typical surface reflectance of 0.15 and viewing/illumination geometry matching common cases of AVHRR observation in summer, we find that variability of 0.3 in AOD can cause differences of up to 5% (relative) in surface reflectance for both AVHRR CH1 and CH2, with the broadband effect being in the same order of magnitude. We can therefore estimate that typical additional relative uncertainty is likely in the 0-6% range, although larger effects remain of course possible.

Wilson, R. T., 2013, Py6S: A Python interface to the 6S radiative transfer model, *Computers and Geosciences*, 51, p166-171



- There are many Land Cover products, such as the USGS land cover products, the GLC2000 product, and so on. Do they have the same land cover classification principles? Do they have the same spatial resolution? If they have the unsame land cover classifications, how to merge them?

The different LC data are nearest neighbor-resampled to each AVHRR image within the limits of their resolution. However, it is important to note that in the albedo retrieval, land cover is treated only through coarse "archetypes" such as cropland, grassland, or barren. The various LC classes are mapped onto these archetypes with rules specific for each LC product. The procedure is space-consuming to explain in the manuscript, but the full details are available in the CLARA albedo Algorithm Theoretical Basis Document (ATBD), available freely through the CLARA-A3 DOI.

- Are the same albedo retrieval algorithms in the open wate and the closed water?

Yes, only one algorithm applies for all surfaces classified as water. Thus, large enough rivers do appear on the global surface albedo maps of CLARA.

- I can't understand the sentence "Note that the AVHRR-observed reflectances are not used in the estimation of ocean surface albedo." Why the AVHRR reflectance can not be used for generating land surface albedo?

Water albedo is determined to a large degree by the solar geometry and near-surface wind speed (waves, whitecaps), and its variability is less pronounced than for land surfaces. Also, given that the computational burden spared by treating ocean albedo through a model rather than a full atmospheric correction-BRDF-NTBC albedo retrieval is very considerable over the decadal and global scale of CLARA, we have opted for the described processing choice.

- Does the statistics parameter used in Eq (2) and (3) can be used in the global scale?

Yes, the statistical relationships were derived from long timeseries of measured albedo data from all available BSRN sites with long-term coverage. While they represent the best-fit approximation, implying that cases with larger errors will occur, the underlying data mass is nevertheless large and our validation activities did not show any immediately clear cases of erroneous behavior at large scale.

- How to calculate the diffuse and direct radiation? How to calculate the CP? Which data can be used?

Cloud probability (CP) is calculated during the cloud parameter processing of CLARA-A3, which is a preceding step to the albedo estimation. The process is described in the CLARA-A3 overview paper of Karlsson et al. (2023), we will add the reference again to line 214 for clarity. Apart from this information and the solar zenith angle which comes from the satellite/solar geometry data, eq. 5 describes how direct radiation fraction is calculated, with diffuse radiation fraction being 1 – direct radiation.

- I suggest to more quantitative assessment of the new released CLARA albedo. The scatter plots can be used here both in the snow-covered surface and snow-free land surface.

We are unsure what is meant here. Figure 6a already shows the scatter plot of bias in all snow-free overpass-level BAL against the corresponding in situ measurements. The metrics in Table 4 are definitely quantitative for land, snow/ice and sea ice surfaces. If the reviewer wishes for a scatter plot of snow albedo bias, we will provide that for the pentads and monthly means as a supplementary figure.

- Which method was used to assess the representastiveness of the site?

This is explained on lines 301-332; we extract the site areas from high-resolution dynamic land cover data and assess its heterogeneity and resemblance between the measurement site coordinates and the 0.25 degree CLARA grid cell which contains it. For the ice sheet sites, we consider the coverage of ice in the CLARA grid cell as the metric for representativeness because of the large albedo difference between snow/firn/ice and snow-free terrain.

- I found that many sentences abou the quality of the new released albedos do not have the necessary figures or the tables to support, such as the sentence from 261 to 264, the sentence from 256 to 260, Line 265-274.

Very well, we will add supplementary figures containing the necessary reference data for skewness/kurtosis on large scale (first & second case), and the CDR-ICDR differences.

- How to select the cloud-free in situ albedo measurements to validation of the new released albedo product?

This is explained on lines 336-341; the validation site coordinates are tracked during processing, and if found in the overpass being processed, the relevant data are extracted and stored. This yields time series of clear-sky periods at each validation site.

- I suggest the author giving a scatter plot between the CLARA albedo and MCD43D51 in the global scale to show the accuracy of the CLARA albedo.

Very well, we will amend Figure 10 with the scatter plot.

- I found that the larger biases exist between the CLARA albedo and MCD43D51 albedo, especially over theSouthern Hemisphere. What are reasons?

Largest differences between CLARA and MCD43 occur over tropical forests (evergreen broadleaf). This has consistently been the case since the first CLARA release, as seen in Figure 9 of Riihelä et al. (2013). Alongside differences in BRDF modeling, high aerosol loading and subpixel cloud contamination in the coarser AVHRR imagery have been proposed as explanations for the behavior. Desert regions are the other notably different region, likely also related to aerosol loading and surface BRDF treatment.

- The DPI fo the figures need to be improved.

The figures were uploaded at 300DPI as per journal guidelines. We of course have higher-resolution versions available as needed.